It may, however, prove to be a variable star of long period, like the 8th magnitude orange-coloured star remarked by the same observer near Procyon in the autumn of 1833, the existence of which is supported by the observation of Mr. Isaac Fletcher, as described in Smyth's *Sidereal Chromatics* and elsewhere, and we believe by the experience of the Rev. T. W. Webb. There is now a star of the 9th magnitude, following μ Cassiopeæ, $17^{s}{\cdot}2$ and 15′ 38″ south; this is clearly Argelander's star + 53°, No. 228 of the "Durchmusterung," there estimated 9·5, a considerably fainter object than an average 9th magnitude in Bessel's scale; its place would appear to correspond better with that of Smyth's star following his 6th magnitude, nearly on the parallel, than with that of the missing one. Probably this small star may be variable also; its place for the beginning of the present year is R.A. 0h. 59m. 58·3s.; N.P.D., 35° 41′ 27″.

Smyth thought his 6th magnitude star, omitted by Piazzi, might have had "something to do with the mistakes of Flamsteed respecting μ, alluded to by Mr. Baily." These mistakes seem rather to have originated in the confusion of the stars θ and μ, and although Baily doubted if the place of the latter, which he gives from Halley's edition of 1712, could be depended upon, it will be found to agree very well with that of μ carried back from the position in the Greenwich Catalogue of 1860, with Mädler's proper motions.

Should any reader of this column have had the curiosity to look for Smyth's reddish stars, perhaps he will communicate the result of his examination of their neighbourhood.

THE DOUBLE STAR Σ 2120.—Mr. J. M. Wilson has favoured us with the following measures of this star, made at the Temple Observatory, Rugby, by himself and assistants:—

	Pos.	Obs.	Dist.	Obs.
1872·48	262°·9	4	3″·78	2
73·50	261°·7	6	3″·65	2
74·62	258°·5	4	4″·2	2

Comparing these measures with the formulæ for rectilinear motion already given in NATURE, the following differences are shown:—

	Pos. ($c-o$)	Dist. ($c-o$)
1872·48	− 0°·4	+ 0″·65
73·50	− 0°·3	+ 0″·91
74·62	+ 1°·8	+ 0″·51

Mr. Wilson has had a suspicion of variation in the magnitude of the companion, but thinks this may be owing to atmospheric circumstances.

THE MINOR PLANETS.—It is notified from Berlin, in M. Leverrier's *Bulletin International*, that the small planet detected by M. Perrotin at the Observatory of Toulouse, on the evening of Sept. 21, in R.A. 23h. 16m. 8s. and N.P.D. 95° 12′, is a new one, and will therefore be No. 149. The brighter members of this group now near opposition are Bellona, Clotho, and Thyra. Clotho will be between the 8th and 9th magnitude; the calculated places are, for Greenwich midnight, as follows:—

	R.A. h. m. s.	N.P.D. ° ′
Oct. 23	3 34 47	90 36·0
,, 27	3 32 50	91 17·0
,, 31	3 30 30	91 55·8
Nov. 4	3 27 51	92 31·6
,, 8	3 25 0	93 3·4

TRANSIT OF COMET 1826 (V.) OVER THE SUN'S DISC.—It was remarked by Gambart that the comet discovered by Pons on the 22nd of October, 1826, the "comet in Bootes," as it was called at the time, must pass over the sun's disc on the morning of November 18, and he was at some pains in correcting the elements of the orbit, with the view of deciding whether the comet had left the disc, before it was examined by himself and Flaugergues, the only two observers who were at stations partially free from cloud on the morning of the transit. A letter from Gambart addressed to Sir John Herschel, at that time president of the Royal Astronomical Society, conveying an intimation of the expected phenomenon, arrived in London on the evening previous to the transit, and, as stated in vol. iii. of the Memoirs of the Society, "the news of so rare a phenomenon was immediately spread, and few astronomers in or near the metropolis failed to be prepared for it;" the sun, however, was totally obscured at rising, and for the whole day, by clouds and rain. A dense fog appears to have prevailed very generally over the continent of Europe, so that, as mentioned above, Gambart at Marseilles and Flaugergues at Viviers alone obtained a view of the disc during the interval in which it was expected the transit would take place.

The following particulars of the transit founded upon a new calculation from the corrected elements of Gambart, closely representing the observations between Oct. 26 and Dec. 11, may possess interest for the astronomical reader.

The comet's true geocentric positions, for Greenwich mean time, were:—

		R.A. ° ′ ″	N P.D. ° ′ ″
Nov. 17.	17h.	233 7 5	108 51 48
,,	19h.	233 7 52	109 11 50
,,	21h.	233 8 38	109 31 26

Whence, correcting for aberration and taking the sun's places from Carlini's tables, the following differences of R.A. and N.P.D. of comet and sun's centre result:—

	h.	Diff. R.A. ′ ″	Diff. N.P.D. ′ ″
Nov. 17.	17	+ 5 31	− 16 48
,,	18	+ 3 19	− 7 19
,,	19	+ 1 7	+ 2 2
,,	20	− 1 6	+ 11 17
,,	21	− 3 19	+ 20 26

And as referred to the centre of the earth, we find:—

h. m.
Ingress Nov. 17 at 16 59·9 at 19° from sun's N. point towards E.
Egress ,, 20 22·5 at 184° ,, ,, ,,

At Marseilles, the egress would take place at 20h. 59m. apparent time, the equation of time being 14m. 43s. additive to mean time.

As is well known, neither Gambart nor Flaugergues were successful in detecting this comet upon the sun's disc, but though visible at one time to the naked eye, it was not of any considerable degree of brightness.

*FAYE ON THE LAWS OF STORMS**

Mechanical Theory of Whirling Movements.—Before we enter on the mechanics of these phenomena, it is necessary to clear the way by the removal of certain ideas which constantly recur to the mind of the reader, and by distracting his attention render any clear unbiassed perception of the subject altogether impossible. This preliminary discussion will embrace the three following points: the part played by electricity in the formation of whirlwinds and cyclones, the significance to be attached to the indications of the barometer, and the part played by currents of aspiration in the modern theory of the trade winds.

1. Part played by Electricity.—Certain physicists, dissatisfied with the views we are about to refute, and struck with the electrical phenomena which so often accompany hurricanes, typhoons, &c., have supposed that electricity is the determining cause. We shall perhaps give a clear idea of this theory by reverting to the electrical explanation of hail, the phenomena of hail being intimately bound up with that of whirling movements. It is well known that hailstones are composed of layers of ice alternately opaque and transparent; in breaking them we see in their texture the evidence of successive and alternate

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* Continued from p. 501.

actions to which they have been subjected. Hence, it is argued, they must have been suspended in the air by some force to allow time for these alternate actions to take effect. Is the force in question not that of electricity? Let us suppose two clouds, superimposed the one above the other, to be charged with opposite electricities; if the crystals of ice which are often to be met with in the upper regions of the atmosphere happen to be in the interval between the two clouds, they will be attracted by the nearest, and thereafter repelled as soon as they have received by contact the electricity with which it is charged. Instantly being attracted by the other cloud, they rush towards it and are immediately charged with the opposite electricity; and this alternate play, during which the hailstones receive successive accretions from the vapour abstracted from the clouds and congealed by the cold of the original hailstone or of the space intervening, will go on till the hailstones acquire a weight too great for them to be any longer suspended, or till an electric discharge has destroyed the opposite electricities which have accumulated on the surfaces of the clouds. At this instant the hailstones fall to the ground by the simple effect of their own weight.

To the same cause the formation of waterspouts has been attributed. Let us suppose a low cloud highly charged with electricity and producing by induction on the water of the sea a powerful accumulation of statical electricity of the opposite sign on its surface. The mutual attraction of these two electricities, the cloud on the one hand, the sea on the other, while powerless to produce contact, will nevertheless give rise to two opposing protuberances in the oppositely electrified bodies. At that point the electricities will acquire a tension the greater as the protuberances continue to assume forms more elongated. As the attractive action goes on increasing, these two protuberances will gradually approach each other between the sky and the earth, and will ultimately unite, the protuberance descending from the sky passing over a greater space than the other. Then, by the conductor thus quickly formed of water and an elongated fragment of cloud, the electricity of the upper regions will escape into the ground, exerting a destructive action over all obstacles in its way. It is also to be noted that the instant when the waterspout is thus completed, thunder ceases to roll in the clouds, the reason being that the electricity has found a silent mode of escape. M. Peltier, the accomplished physicist to whom science is indebted for many ingenious researches on atmospheric electricity, endeavoured to reproduce in miniature the phenomenon thus described; but in bringing a highly electrified conductor close to the surface of a sheet of water, he was unable to show any other sensible mechanical effect than a more rapid evaporation.

We shall not, however, insist on the electrical theory of waterspouts. The theory is now rejected, equally with the electrical theory of hail, because if a few waterspouts have exhibited traces of an electrical action, the greater part of the observed facts show nothing of it. Waterspouts and typhoons are mechanical phenomena, in which electricity plays not the principal part, but a part altogether subordinate. There was a time when the tendency was to explain everything in meteorology by electricity. Whenever any question became obscure, electricity was resorted to as a convenient explanation, and any difficult point was considered as cleared up by an adroit appeal to some laboratory experiment—such as the explanation of the theory of hail from the dance executed by pith-balls between two brass plates. It came, however, to be recognised that, in seeking to identify meteorological phenomena with laboratory experiments, the risk was run of losing sight of the real circumstances of nature and putting in their stead those of the laboratory. The clouds of Volta are real plates of brass, and the spark of the induced conductors, as they are brought near each other, always forgets to manifest itself when the two fragments of waterspouts unite together.

2. Barometer.—The question of the barometer is more difficult. The diminution of pressure which precedes and accompanies cyclones has always been considered as a proof of aspiration. It is certain that the continual lowering of the barometric column—a lowering the maximum of which occurs in the very centre of the hurricane—is a phenomenon so constant as to serve as an infallible warning to sailors. In certain seas and at certain times of the year, the sailor ought to keep his eye on the barometer as much as the compass. But what is the significance of this diminution of pressure? Does it prove that the air over our heads is rarefied? If a vertical column of air was rarefied, the equilibrium would be re-established not at its lower part only, that is to say at the expense of the lower stratum; to effect this, a solid envelope would be necessary to isolate the column through its entire length, leaving only a free opening at its base. But the column, on the contrary, being everywhere in communication with the atmosphere, the equilibrium would be quickly restored by a simultaneous afflux of the strata at all heights, and not merely by the afflux of the lower stratum alone. This, however, is not how things take place. The diminution of the barometer does not indicate a vacuum in the upper regions, but is the result of a movement. Involuntarily, when we speak of the barometer, we always regard pressure in the statical condition, as if the atmosphere was constantly in equilibrium, whilst in reality it is in continual motion. If there was reason to believe that the different layers of air do not mix in crossing each other, it could not be denied that the aqueous vapour in its continual ascent from the ground and the sea does not traverse the successive strata on its way to the more elevated regions of the atmosphere, to be there condensed into minute crystals of ice. And when under the action of other causes, the whole strata of the atmosphere flow almost horizontally, like vast rivers, between strata absolutely immoveable, producing everywhere condensation of vapour and heavy rains, it is doubtful if even the statical principle of the equality of pressure could in every sense be employed; the barometric pressure and its variations ought no longer to be interpreted from the statical point of view only, especially if it arises from gyratory movements on a vast scale. There is here a question belonging to the dynamics of fluids which mathematicians have not yet explained; but in the meantime we ought not to forget the essential distinction between dynamical and statical pressure so as to suppose that every rapid fall of the barometer indicates a sudden rarefaction of air overhead, and consequently aspiration from above downwards.

3. Trade Winds.—The question of the trade winds is connected with the preceding subject. If the air be considered only by itself, it will arrange itself in a state of equilibrium, in homogeneous layers of varying densities, which decrease with the height. These layers will be bounded by ideal level surfaces enveloping the globe, and which may here be regarded as spheres. If the action of the sun, whose heat-rays are specially absorbed by the lowest strata and by the aqueous vapour, is felt more energetically over the torrid zone than in higher latitudes, the inferior strata will expand, and pressing upwards will raise the upper strata to a higher level. The equilibrium being thus disturbed, it will tend to re-establish itself by a general flow towards the coldest regions after the manner of ocean currents, or like immense rivers which have for their beds level surfaces, of which we are about to speak.

On the other hand, the temperate and cold zones receiving this overplus of air, their lower strata taking a movement inverse to the above, set in towards the large space of the equatorial regions where the density of the air is less; and leaving out of view the effects of the earth's rotation, which diverts these currents from the direction of the meridians, we have there the true cause of the trade winds of the high regions, of which the lower trade winds are only the counterpart and the result. The lower trade winds are ordinarily attributed to an equatorial rarefaction and to the indraught which results from it. On this account, the indraught being direct and ceasing with the day, the lower trade winds ought to show, just as sea and land breezes, an alternation from day to night, of which there exists no trace. In considering the trade winds, on the contrary, as the indirect result of the draining effected in the region of the upper strata, we see that the intermediate mass plays the part of the air receiver of a hydraulic machine, which, by annihilating differences of velocity, produces a steady flow, but which placed under the direct action of the motive power would have been intermittent.

The theory of indraught or aspiration represents, on the contrary, vast regular currents of the atmosphere as shown by Fig. 12. We here see at the equator a sort of chimney towards which the air is drawn, and up which it ascends, and thereafter takes a course to north and to south. The proof that matters do not take place altogether in this way, and that the expansion of the air on all sides in the zone most highly heated by the sun does not there upset the order and the statical superposition of the strata, is astronomical refraction, whose laws are the same at the equator as in temperate regions; there is in addition the perfect regularity and the smallness of the barometric oscillations—conditions little compatible with those of a colossal updraught, or even with the behaviour of the trade winds, which no one has ever seen at the confines of the zone of calms begin to assume a vertical direction.

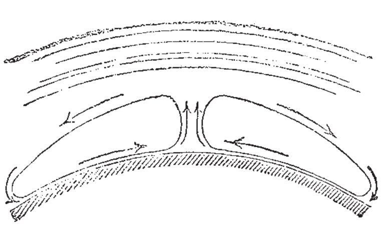

Fig. 12.

If we have at length succeeded in dispelling the idea of vertical aspiration from which has been deduced the direct cause of all aërial currents and all tempests, and the idea of electricity considered as the chief agent in the mechanics of the atmosphere, and lastly the confounding, so frequently, of statical pressure in a fluid mass in repose with dynamical pressure in a medium traversed throughout by movements the most capricious, we shall have no difficulty in accepting the following considerations, for the subject being in this way simplified, the result is a simple question of pure mechanics.

Vortices or Eddies with their Axes vertical to the Current of Water.—If the question exclusively concerned pure mechanics or mathematics, we should be stopped at the very threshold of the inquiry, because mechanics does not yet embrace the study of gyratory movements in liquids or fluids. We have not up to the present moment succeeded in submitting to analysis exact problems of hydrodynamics, unless in very special cases in which we may consider fluids as composed of elements of volume containing always the same molecules, of such sort that their masses are invariable and that the molecules situated at the surface or on any of the sides will always remain at the surface or at the same side. Besides, the trajectories of the liquid filaments ought never to present those re-entering or spiral-like curves which we, however, so frequently remark. If we set out with these restrictive hypotheses, the question cannot be attacked by analysis. In other words, we are forced absolutely to exclude all that relates to the movements with which we are now dealing.

But where analysis is still powerless, experiment and observation remain for our guidance. Whirling movements make their appearance not only in gases; they are equally found in liquids, where they are more manageable, since they can be followed by the eye and even produced at pleasure. We shall therefore commence with the movements which are observed in liquids after we have drawn a vital distinction between the different whirling movements with which we are dealing. Air and water present in fact very complicated gyrations, some ebullient, transitory, and without any stability of figure, others perfectly regular and persistent. They are distinguished by a very simple geometrical figure: the second class have their axis always vertical; the others turn round axes diversely inclined. A moment's reflection will enable us to account for the difference. In the case of a horizontal gyration the spires keep clear of the surrounding layers past which they whirl, or only very slightly graze them in their course. In the first case all motion of the layers disappears; that of the surface even no more exists; because at the surface of separation between the water and the air the eddying spires issue from the liquid mass and cut through or carry away to the interior the air placed above so as to produce the phenomena of spray, froth, foam, and emulsion.

Let us then confine ourselves to whirling movements round a vertical axis, which the student of hydraulics knows and observes, and which can be reproduced at will and studied experimentally. These are, in truth, regular persistent movements which obey laws very simple and precise. The general law which embraces all these phenomena is as follows:—When there exists in a current of water differences of velocity between the filaments in lateral juxtaposition, there tends to be generated, by reason of these inequalities, a regular gyratory movement round a vertical axis. The spires described by the molecules are sensibly circular, with their centres about the axis. These are, speaking more exactly, the spires of a helix, slightly conical and descending, so that in following a molecule in its movements it is seen to turn rapidly in a circle round the axis, which it imperceptibly approaches, descending with a velocity very much less than the linear velocity of rotation. Evidently the centrifugal force which results from this gyratory movement must be everywhere counterbalanced by the pressure of the surrounding liquid; there is then inside these eddying spires, at least at their upper orifice, a slight lowering of the pressure which discloses itself at the surface of the liquid by a feeble conical depression centered about the axis of rotation.

The two following characteristic properties are demonstrated by analysis:—(1) The entire whirl may be regarded as separated from the surrounding fluid, which remains immoveable, by a surface of revolution whose meridian curve has its concavity turned downwards. In other words, the exterior figure of the whirling mass is in the form of an inverted cone pointing downwards. (2) The angular velocity of a molecule increases in proportion as it approaches the axis; it is inversely proportional to the square of its distance from the vertical axis. Hence the linear velocity increases in simple inverse proportion to its distance from the axis. If we consider how great the breadth of the whirling cone in the current of the water occasionally is, relatively to the size of the lower orifice, we shall understand how a gyration which appears sluggish at the surface and at the circumference becomes violent at the base of the funnel-shaped eddy.

These two laws, it must be here observed, are applicable not only to liquids but also to gases. They are easily verified by the experiment of throwing a little dust into water in which an eddy has been formed, when the funnel-shaped figure and circulatory movement of the entire mass and the increase of velocity towards the centre will be at once seen.

The descending movement of these whirls may be examined by the preceding analysis, but observation has long since placed the matter beyond doubt. Everyone knows how much eddies in the current of a river are dreaded by bathers; when a swimmer has the misfortune to be caught in one he is drawn down by a rapid rotation even to the bottom of the water. There, the expert swimmer, knowing how to reserve his strength in place of expending it in useless efforts, extricates himself by resting on the bottom, and, disengaging himself from the eddy, rises quickly to the surface. Not only may men be thus engulphed, but masses of floating ice, or even small vessels, are drawn to the bottom by whirlpools, and thereafter are extricated and rise to the surface only by the obstacle afforded by the bottom, and by the contraction downwards, more and more marked, of the whirling mass of water.

These phenomena can be artificially produced in a large mass of still water, at a part where a rapid movement of gyration is communicated by a suitable mechanical appliance.[*] If we strew dust on the surface, in order to render the phenomena visible, it is seen that gyration is propagated in the form of a cone from above downwards, even to the bottom of the vessel, drawing the dust along with it. Count Xavier de Maistre, who has published in the *Bibliothèque Universelle de Genève* some interesting experiments on this subject, has shown that a layer of oil placed over the water of the funnel-shaped eddy is drawn towards the bottom by a gyratory movement; then, when it comes in contact with the obstacle presented by the base, the oil reascends in globules all round the eddy which it has quitted. There is thus here a double vertical movement—the first regularly descending along the spires of a conical helix, the second ascending and exhibiting in its ascent no geometrical figure, but rising to the surface irregularly *round about* the eddy. It is natural that the liquid thus drawn to the bottom should thereafter ascend more or less, not, be it noted, in the eddy down which it had been carried, but outside it, through the surrounding liquid.

This gyratory movement, which thus concentrates towards the point of the eddy the sum of the moving forces which the funnel-shaped whirl embraces in its vast expanse, ought to produce at its base a certain amount of mechanical work, and observation confirms this idea. The powerful whirlpools of our rivers plough up their beds and thus expend on the soil the force which they have acquired near the surface at the expense of the inequalities of velocity of the general current. And as all currents of water possessing some little depth present like inequalities of velocity among their lateral filaments, on account of the friction of the water against the banks, numerous whirlpools are constantly found whose action consists in finally absorbing these inequalities and regulating the flow of the water, so that the general velocity of the river is perceptibly reduced.

Vortices or Eddies with Vertical Axes in Gases.—All these phenomena are found in gaseous masses traversed by horizontal currents. In currents of this sort, inequalities of velocity will equally give rise to whirling movements round a vertical axis, and, as may be constantly observed, these gyrations will still assume the figure of a truncated cone in an inverted position, which becomes visible when any circumstance occurs to interfere with the transparency of the air. Equally as in the case of water, the gyration of a molecule will be the more rapid the nearer it approaches the centre. The analysis which confirms, or rather explains these phenomena is as applicable to gases as to liquids. Need it be said that waterspouts, from their appearance alone, range themselves in this category? The mechanical identity of whirls formed whether in liquids or in gases is found in all the details—such as the descending movement of waterspouts whose point is seen gradually approaching the earth, and in the abrading force which whirlwinds thus exert on the ground in breaking and beating down objects which obstruct their course—acting thus like a plate fixed perpendicularly at the end of a vertical axis whirling rapidly round. This action evidently ceases when the lower orifice of the waterspout rises a little; it recommences with energy each time that the whirling cone is lowered so as to be brought into contact with any opposing object.

We have only further to prove another characteristic of eddies in a stream of water not less general, in order to complete the study of the analogous phenomena in fluids. At the instant when there is formed in a moving mass of water one of these gyrations which are solely due to inequalities in the general current, it is evident that the eddy thus formed and isolated by an invisible sheath, so to speak, will follow the mean velocity of the current, because nothing can bear away the chief part of the velocity to the molecules which compose the eddy. We shall see it follow the line of the stream, preserving its axis in a vertical position and continuing a longer or a shorter time, or until resistances of every sort have exhausted its force. It will follow the same line of the stream as that taken by a floating object without losing its circular form, and without ceasing to act on the bottom, if it extend so far down, as long as its store of energy is inexhausted.

A distinction must be made between these travelling eddies and the great eddies in deep still water which are ceaselessly formed and re-formed at a post fixed at the turning of narrows of a river. When in such places the current makes itself felt it incessantly bears away with it the spires thus formed; the phenomenon is unceasingly renewed, giving rise to those stationary eddies in rivers which have no analogy to those of the atmosphere, and which appeared to play an important part in deepening the beds of rivers.

(*To be continued.*)

THE LARGE REFLECTOR OF THE PARIS OBSERVATORY

M. WALLON, the French Minister of Public Instruction, presided on the 7th inst. at the sitting of the Council of the Observatory, and at the end of the *séance* he made an official inspection of the large refractor. On the 9th the representatives of many of the Parisian papers were present at the Observatory by invitation of M. Leverrier; the weather, unfortunately, was very tempestuous.

The telescope was left under its iron house, but every detail was carefully explained by M. Leverrier, assisted by M. Wolff, the chief astronomer for physical observations. M. Leverrier praised very highly the skill displayed by the constructors, MM. Eichens and Martin.

The weight of the moveable part is nine tons; the mirror is 120 centimetres in diameter, with a focal distance of 6·80 metres. The weight of the mirror is only half a ton, instead of four tons, which would be necessary for a metallic one; its cost amounts to 2,000*l*.

The telescope is suspended like a refractor in an ordinary equatorial. The ocular is placed in front.

On the 8th minute stars were observed by M. Wolff with a magnifying power of 500, which has been found to answer excellently. An ocular multiplying 1,200 times, and perhaps another, 2,400, will be constructed. A micrometer is being made.

The seeker is in front, and can be rotated with the

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[*] These experiments must not be confounded with the experiment of water poured into a vessel to which a movement of rotation round a vertical axis has been communicated. In this case the free surface becomes hollow whilst the water rises along the sides of the vessel. A condition of equilibrium is soon established totally different from the dynamical phenomena we are here discussing. Thus the central depression is parabolical and not conical, and the angular velocity of the fluid molecules is constant, whereas it varies in the movements of eddies in the inverse proportion of the distance from the axis of rotation.